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FIELD EVALUATION OF AN ELECTRONIC BATTLEFIELD COMBAT CASUALTY MEDICAL DATA COLLECTION DEVICE (MEDTAG)

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SUMMARY

Problem

Paper-and-pencil approaches to recording medical data are generally inefficient and time-intensive. Furthermore, when used on the battlefield these approaches often fail to provide adequate casualty treatment history, which negatively affects the quality of follow-on care.

Objective

To overcome the deficiencies of manual methods of documentation, the Navy has developed a prototype electronic medical tag (MEDTAG) to collect critical combat casualty medical data. The present paper seeks to evaluate the field effectiveness of the MEDTAG using two methods of data capture.

Approach

Two studies were conducted in which measures of MEDTAG documentation time and data quality were obtained for comparison with the data collection capabilities of the Field Medical Card (FMC). In the first study, the MEDTAG prototype was programmed to implement a user-directed documentation method. In the second study, the MEDTAG was programmed to implement a combination of user-directed documentation and a prompting sequence in which the user was asked to provide data on preselected items.

Results

The MEDTAG, implementing the user-directed data input method, produced documentation faster than the FMC by an average of 29 seconds. Significant increases in the quality of treatment, patient condition, and patient disposition data were also realized. The FMC, however, produced more accurate and complete injury data.

When the user-directed method was combined with a prompting sequence of data input the documentation rate was improved further, with the MEDTAG taking 56 seconds less to complete than the FMC. Furthermore, the combination of prompting and user-directed methods produced significantly more accurate and complete treatment, patient condition, and patient disposition data than the user-directed method alone. No significant differences between the combined methods and the FMC were found for injury documentation quality.

Conclusions

The results of these studies clearly demonstrate that the MEDTAG device can conduct field medical documentation faster than the FMC during combat simulations. This time advantage is particularly remarkable because the accuracy and completeness of the data were not compromised by the faster documentation times. Instead, the MEDTAG actually surpassed the FMC in terms of the quality of data documentation.

INTRODUCTION

The only North Atlantic Treaty Organization (NATO) approved instrument for collecting battlefield casualty medical data is the Field Medical Card (FMC) DD Form 1380. This instrument, which had remained unchanged since its implementation during the early years of the Vietnam conflict, was declared to be deficient in the Medical Readiness Strategic Plan (MRSP, 1988). As a result, a quad-service working group was formed and instructed to develop a revised FMC (FMFM 4-50 1990).

Substantial effort was expended by the quad-service working group to develop a card that was easier to read and complete. Evaluation of the revised card by Naval Health Research Center (NHRC), however, concluded that many of the most critical and longstanding problems persist. For example, the revised cards still require a writing instrument (which may get lost or broken), and documentation continues to be difficult at night. The cards still have to be carried by corpsmen in booklets, which both takes up valuable space and prevents the documentation of self-aid or buddy-aid. Therefore, the data collection capability of the instrument remains unacceptable despite the working group's effort to improve the FMC (Wilcox & Pugh, 1990). Finally, under the constraints and pressure of battle, the time required to complete the card is more than Fleet Marine Force (FMF) corpsmen are willing to relinquish (Wilcox, Galarneau, & Fitzgerald, 1993).

In general, paper-and-pencil procedures are inefficient, time-intensive approaches to medical documentation. When applied to the battlefield, these approaches fail to provide adequate information regarding the treatment histories of casualties processed through the medical chain of evacuation (Wilcox & Pugh 1990; Wilcox, Galarneau, & Fitzgerald, 1993). Automation of the field medical record, however, may offer solutions to the persistent problems associated with combat medical documentation. For example, through automation, prestored patient identification and medical information can be retrieved quickly on the battlefield. No writing instruments or forms are required, and all data entries can be automatically time-and date-stamped. Backlighted displays allow for nighttime use and documentation of buddy-aid and self-aid is feasible because the documentation device is carried by the individual being treated.

To explore this solution further, NHRC developed the concept of an automated method of capturing battlefield medical data, which uses an electronic tag worn by combat personnel (Galarneau & Wilcox, 1993). This device, called MEDTAG, includes an integrated read/write capability, a backlighted LCD display to present users with menu options, two data entry buttons,

an internal clock for time/date-stamping, and a data communications port for transferring information to and from a host computer.

Evaluation of an initial prototype demonstrated that automation of the combat medical record was feasible (Galarneau & Wilcox, 1993). The prototype device proved that it could capture and record critical combat medical data without reliance upon auxiliary reader/writer equipment. The MEDTAG's menu-driven, two-button method of operation exhibited significant potential for enhancing the user's ability to quickly and accurately enter and extract data. The device demonstrated the ability to accommodate buddy-aid and self-aid and was widely accepted by Marine Corps personnel and FMF corpsmen. The backlighted screen facilitated nighttime documentation and data were easily reviewed and augmented at various levels of treatment because the device remained with the patient throughout the treatment process.

Enhanced MEDTAG Prototype

Various refinements capable of increasing the operational effectiveness of the device were identified and implemented as a result of this initial evaluation. Modifications to the physical form (Fig. 1) and function of the device as well as to the software governing data capture and retrieval were implemented. Three identical units, incorporating the refinements listed below, were fabricated for field-testing in this study.

Hardware. In addition to the features already mentioned, the enhanced MEDTAGs used for this study are resistant to shock and environmental contamination and incorporate a potentiometer, which permits backlight intensity levels to be adjusted up or down to meet the tactical requirements of a range of combat situations. A one-way slide switch, illustrative of the irreversible nature of activation, is used to transition the device to the active/data collection mode of operation. The power supply, located internally, is provided by a single 9-volt alkaline battery.

Software. The enhanced MEDTAG incorporates a "status check" feature that displays system information, such as preloaded personal identification data, current time, and a warning to change the battery when power is low. Upon activation of the device, preloaded personal identification data and warnings, alerting care providers to allergies or pre-existing medical conditions, becomes immediately available. In addition, activation automatically initiates the patient injury and treatment time line by recording the current time and date.

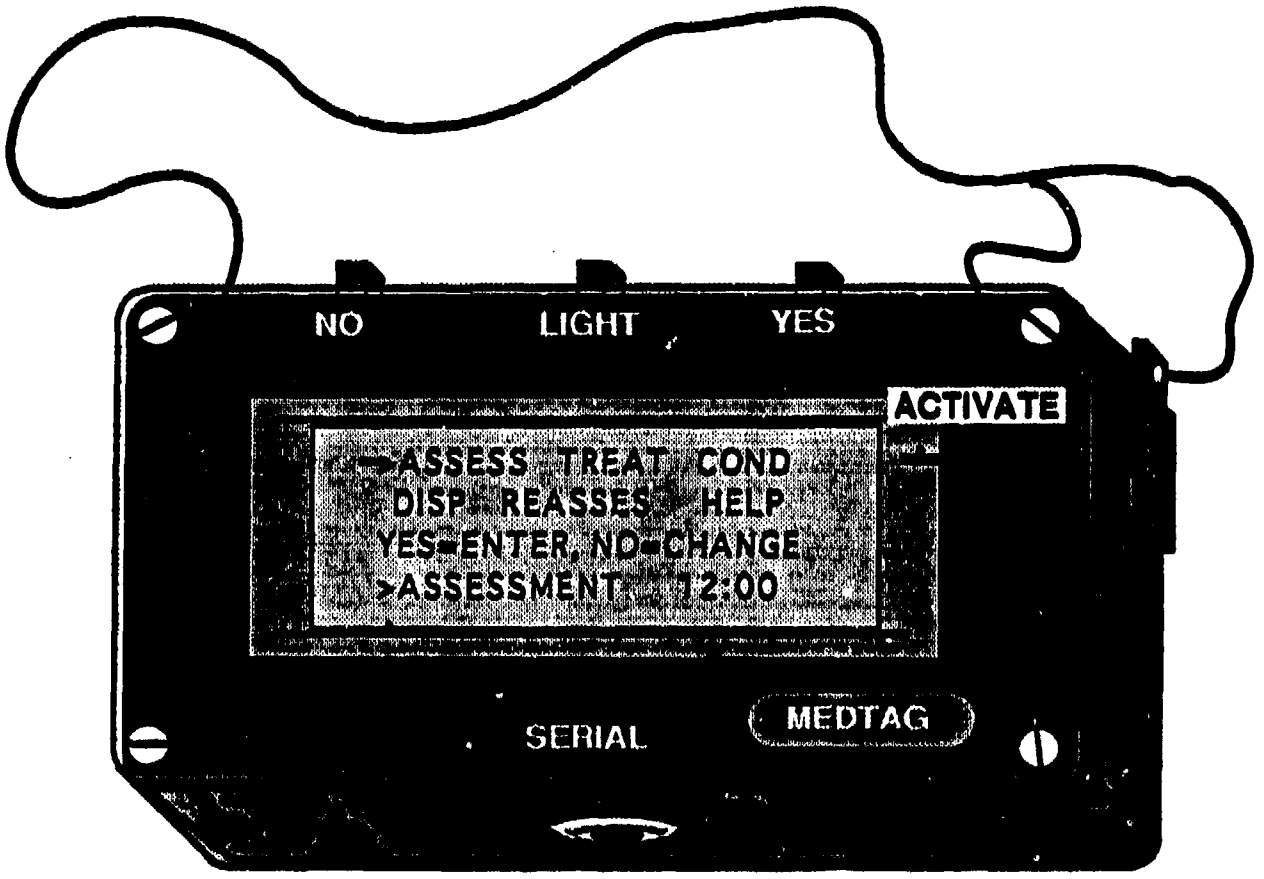

Figure 1. Artist rendering of the enhanced MEDTAG prototype.

The MEDTAG also calculates both the Glasgow Coma Scale (Hedges, Feero, Moore, Haver, & Shultz, 1987) and the Revised Trauma Score (Champion, Sacco, & Copes, 1989), using patient condition data whenever the elements comprising the measures are entered within a five-minute interval. Upon entry of the required data elements, the calculations are automatically computed and the results are displayed upon request. To facilitate the review of previously recorded information, an automatic screen scrolling feature is used. The MEDTAG displays four lines of personal identification and treatment data at a time and automatically scrolls the data from top to bottom, displaying a new line of data at a rate of approximately 1 line per second.

In the current paper, two studies are described in which measures of MEDTAG documentation time and data quality are obtained for comparison with the data collected using the FMC. In the first study, the MEDTAG was programmed to implement a user-directed documentation method in which each item must be selected by the user. In the second study, the MEDTAG was programmed to implement a combination of user-directed documentation and a prompting sequence in which the user was asked to provide data on a set of pre-selected items.

These studies were designed to parallel an earlier study that used the FMC as the data collection instrument (Wilcox, Galarneau, & Fitzgerald, 1993). Design and methodology for all studies were identical in that the same measures of documentation time and data accuracy and completeness were collected on simulated casualties outfitted with the identical set of injuries. The findings from the earlier FMC study have been used as the baseline against which the MEDTAG findings from the current studies were compared.

STUDY 1

METHOD

Sample

Navy corpsmen, undergoing Fleet Marine Force training at the Field Medical Services School (FMSS), Camp Pendleton, California, participated in the study. The FMSS was selected for the study because of the structure of its training program. The school conducts an intensive, 6-week program for U.S. Navy corpsmen designed to prepare them for a combat support role. Two of these weeks are devoted to field exercises in which the corpsmen practice their medical and tactical skills in a simulated combat environment. Field medical documentation is an integral part of these exercises.

Field Conditions

During the field exercises students are placed in mock combat situations and are required to perform simulated treatments on other students playing the role of battlefield casualties. Under these conditions, the corpsmen must continually remain responsive to the dangers of the battlefield environment. They must provide medical treatment without undue risk of injury to themselves, subjecting their patients to further injury, or compromising the position of their unit. In addition to simulated combat conditions, the pressure of battle is further intensified by instructors who continually remind students of the severe time and physical constraints of the situation. Students who fail to act in a timely manner, disregard various patient conditions, or fail to recognize pertinent situational circumstances are made immediately aware of the consequences of their actions.

Under typical FMSS training exercises, two battle scenarios are enacted. One is conducted in canyons located on the FMSS training site and another takes place at a simulated Battalion Aid Station (BAS) set up nearby. The scenarios serve to simulate battle conditions at the first two levels of combat casualty care provided at the first echelon of treatment. The following is a brief description of each locale:

(a) Battlefield Scenario - During battlefield training, a platoon with its complement of corpsmen advances through a canyon that has been set up to provide hostile enemy encounters. Immediately following each simulated ambush, the corpsmen are required to respond to calls for medical assistance and take action to protect themselves and their patient(s) from immediate danger. Simulated treatment is then provided to the patient. After treatment has been rendered, the FMC is used to document the incident.

(b) BAS Scenario - During BAS training, casualty assessment and treatment similar to the first scenario are administered and documented for victims of mass casualty simulations. The pressure under which this work is performed, however, is greatly reduced. The BAS also receives and reassesses those patients evacuated from the battlefield. Once triaged, the casualties are moved into the BAS tent where a second, more thorough, patient examination is initiated and the start of a complete treatment plan begins. This treatment may include the use of intravenous fluids, antibiotics, or opening an airway by surgical procedure.

Simulated Injuries

In both combat scenarios, researchers were paired with Navy corpsmen designated to play the role of battle casualties. All simulated patients in the study manifested the identical wounds. Sucking chest wound and amputated limb moulages were worn by all patients to add realism and to provide data consistency and comparability. "Patients" further simulated an injury by exhibiting behavior consistent with the type of wound they were wearing. In a typical training evolution, corpsmen responded to calls for medical assistance, treated their "patients," and then documented injury assessment and treatments administered with the MEDTAG.

Exercises were carried out in full daylight, in twilight, and in the full darkness of night. During daylight exercises, corpsmen performed treatments and documented their procedures under lighting conditions similar to those of their classroom training. As light levels diminished during twilight and night, corpsmen were required to conduct patient diagnosis and treatment with red-lens flashlights under the concealment of a poncho to prevent detection by enemy units.

Procedure

MEDTAG Extended mode. The primary method of MEDTAG data input, extended mode, operates as an open-ended, user-directed method of data entry. In this mode, users store and retrieve data by traversing a set of menus. The items available in the menus comprehensively cover the spectrum of medical events likely to be encountered in the administration of combat casualty care. This includes the ability to capture, store, and retrieve injury, treatment, patient condition, and patient disposition information. Study 1 focused exclusively upon the evaluation of this method of MEDTAG data input.

Time measurements, obtained by stopwatch, recorded the amount of time corpsmen took to document their medical procedures using the MEDTAG's Extended mode. Time measurements were begun when the corpsmen first touched the MEDTAG and ended when the corpsmen released the device. The recording of documentation time was suspended during periods when the corpsman's attention was diverted to other situational concerns, such as immediate patient need or danger imposed by heightened conflict intensity, and resumed once attention was refocused on MEDTAG. Measures were obtained under daylight, twilight, and nighttime conditions during both battlefield and BAS training scenarios. Following each patient encounter, the MEDTAG documentation data were downloaded to a laptop computer for storage.

Analysis

Means and standard deviations were computed on documentation time for each level of ambient light and combat intensity. T-tests were used to determine whether significant differences existed between groups.

Data quality values were obtained by examining each MEDTAG observation to determine if the corpsman reported the data accurately and completely. Four primary categories of documentation were examined. These included injury diagnosis, treatment administered, patient condition, and patient disposition. Standard patient treatment protocols, obtained through consultation with FMSS training personnel, were used to establish the levels of documentation considered accurate and complete for both sucking chest wound and traumatic limb amputation injuries. Documentation that correctly reported casualty medical data according to these standards for both injuries was rated as accurate and complete. Documentation that was either inaccurately reported or completely missing for one or both injuries was rated unacceptable. Z-tests were then computed between the categories of data accuracy and completion to determine whether significant differences between documentation methods existed.

STUDY 1

RESULTS AND DISCUSSION

The first 1 to 3 seconds of documentation time were devoted to locating the casualty's MEDTAG and activating the device. Because personal identification data are preloaded and time-and date-stamping automatic, 38 percent of the data required by the FMC is available to the user upon activation. These features allowed the user to focus his documentation effort solely upon the clinically important events of the patient encounter.

MEDTAG Extended Mode

Documentation times for MEDTAG data entered via the Extended mode were measured to determine if the time required to document field medical data was comparable to current manual methods of data collection. The measures were obtained under each of the various levels of ambient light and combat intensity. Table 1 presents the mean documentation time for each condition. These results are compared to those obtained in the earlier baseline study, which used the FMC as the data collection instrument (Wilcox, Galarneau, & Fitzgerald, 1993). The results

Table 1
FMC and MEDTAG Extended Data Input Documentation

Location/ Time of Day	FMC n	FMC Mean Time (min:sec)	FMC SD	MEDTAG Extended Data Input n	MEDTAG Extended Data Input Mean Time (min:sec)	MEDTAG Extended Data Input SD	T
OVERALL	89	3:09	1:08	87	2:40	0:54	3:13*
BATTLEFIELD	42	2:56	0:57	38	2:26	0:54	2.41*
Day	17	2:40	0:48	17	2:23	0:55	0.97
Twilight	10	3:13	1:22	06	2:08	0:38	1:80
Night	15	3:02	0.53	15	2:35	1:13	1:16
BATTLALION AID STATION	47	3:21	1:12	49	2:50	0:49	2.47*
Day	24	3:06	1:13	19	2:37	0:43	1.54
Twilight	07	3:16	1:27	10	2:44	0:45	1:00
Night	16	3:46	1:11	20	3:06	1:00	1:84

* $p < .05$

show that the MEDTAG significantly reduced overall battlefield and BAS documentation time by an average of 29 seconds.

Table 2 presents the percentages of accurate and complete documentation obtained for each measure of clinical data quality. MEDTAG results are compared to the FMC results obtained in the earlier baseline study. A z-test for differences between proportions was computed for each pair of percentages. The findings showed that the FMC documented injury information more accurately and completely than the MEDTAG. This was most pronounced in the documentation of sucking chest wounds, where the FMC had a 94 percent accuracy and completeness rate compared to the MEDTAG's 74 percent.

Use of the MEDTAG, however, produced significantly better results than the FMC in the documentation of treatment, patient condition, and patient disposition. For example, MEDTAG users correctly documented all available treatment data on both injuries 57 percent of the time, whereas the rate for the FMC was 26 percent. Examination of the treatment documentation for each individual injury showed that users of the MEDTAG accurately and completely reported sucking chest wound treatment in 78 percent of the observations compared to 57 percent for the FMC. In the case of amputations, treatment documentation recorded with the MEDTAG's Extended mode was accurate and complete 60 percent of the time compared to 30 percent for the FMC. The MEDTAG also provided superior documentation accuracy and completeness in the areas of patient condition and patient disposition.

These results demonstrated the potential of the MEDTAG as an electronic battlefield data collection instrument. Reductions in the amount of time required for documentation with MEDTAG relative to the FMC were realized across all conditions, and improved data quality was noted in all but the injury categories, where the FMC performed better.

STUDY 2

METHOD

Having demonstrated the MEDTAG's general capability, efforts were then directed toward further improving speed of documentation and data quality. A second method of data input was developed to provide a potentially more efficient method of capturing combat medical data. In this method of data input, users are prompted for predetermined items of information. The type

Table 2

Percent of FMC and MEDTAG Extended Data Input Information Accurately and Completely Documented

FMC n = 89	MEDTAG Extended Input n = 87	z Score	Type of Documentation
			Specific Injury Type Documentation
94.38%	74.71%	-3.62*	o Sucking Chest Wound
90.70%	77.01%	-2.47*	o Amputation
			Specific Injury Location Documentation
95.51%	77.01%	-3.58*	o Sucking Chest Wound
91.86%	80.46%	-2.19*	o Amputation
			Overall Injury Documentation
80.90%	62.07%	-2.77*	o Both Sucking Chest Wound & Amputation
			Specific Treatment Documentation
57.30%	78.16%	2.96*	o Occlusive Dressing applied for Sucking Chest Wound
30.34%	60.92%	4.07*	o Pressure Band., or Tourniquet w/Band. used on Amputation
			Overall Treatment Documentation
26.97%	57.47%	4.10*	o Both Sucking Chest Wound & Amputation
			Patient Condition Documentation
10.11%	52.87%	6.12*	o Patient Condition
			Patient Disposition Documentation
01.12%	70.11%	9.58*	o Patient Disposition

* $p < .05$

of information requested in this prompting mode is limited to the information common to most battlefield encounters and accounts for the majority of the information required by the FMC. This prompting data input method was joined to the primary data entry method (Extended mode), forming an input sequence combining features of both methods. Upon activation of the device, users were presented with the prompting method, called Prompted data input (Fig. 2). Upon completion of the prompting sequence, MEDTAG users entered the Extended data input mode to complete the documentation task. An evaluation of the operational effectiveness of the MEDTAG prototype when both methods of data input are used in conjunction is presented in Study 2.

Sample

Subjects were Navy corpsmen, undergoing the same Camp Pendleton FMSS training program as those used in Study 1.

Procedures

The experimental design, procedures, analyses, and setting used for Study 2 were identical to those of Study 1. In Study 2, however, two separate measures of time rather than one were recorded:

(a) Prompted documentation time - Defined as the total cumulative amount of time used by corpsmen to record the data requested in the Prompted mode (Fig. 2). Recording time for each case was started at the point the corpsman's hand first touched the MEDTAG and terminated with the completion of the final prompted item. The recording of documentation time was suspended during periods when the corpsman's attention was diverted to other situational concerns, such as immediate patient need or danger imposed by heightened conflict intensity, and resumed once attention was refocused upon the MEDTAG.

(b) Extended With Prompting documentation time - Defined as the total cumulative amount of time used by corpsmen to document their procedures using the Prompted and Extended data input modes combined. Recording time for each case was started at the point the corpsman's hand first touched the MEDTAG and concluded when the corpsman released the device.

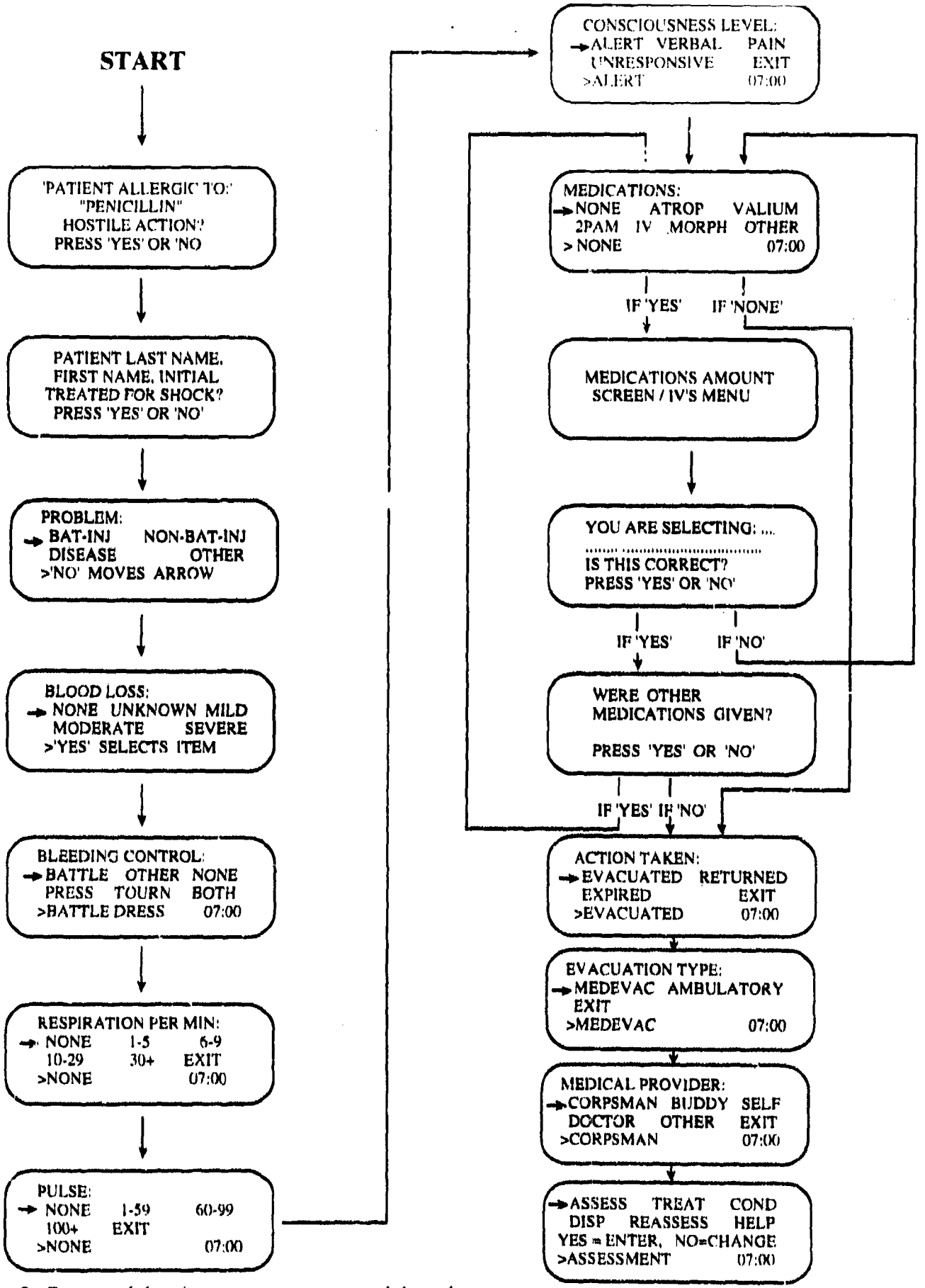

Figure 2. Prompted data input menu screens and data elements.

RESULTS AND DISCUSSION

In addition to having the preloaded personnel identification data and automatic time/date stamping, the user was immediately placed in the Prompted mode. Therefore, the user focused on providing treatment information first.

Prompted Data Input

Measures of Prompted documentation time were obtained to determine the time required for users to respond to a predetermined sequence of questions. The results, presented in Table 3, show that Prompted data entry was accomplished in an average of 41 seconds. Upon completion of the Prompted mode, 23 out of 26 (or 88 percent) of the items required by the FMC have been recorded. No significant differences were observed between levels of ambient light or combat intensity.

Extended With Prompting Data Input

Extended With Prompting documentation time measures were obtained to determine if overall documentation time could be reduced by directly prompting users for a portion of the information rather than require them to determine the next area to be documented. The results, shown in Table 3, revealed that in all conditions combined, data input using the Extended With Prompting mode was accomplished in 2 min 13 sec. This was significantly faster than the Extended data input mode results of 2 min 40 sec reported in Study 1 ($t = 3.79$, $p < .001$), and far superior to the FMC time of 3 min 09 sec ($t = 6.73$, $p < .001$) previously found (Wilcox, Galarneau, & Fitzgerald, 1993).

Table 4 presents the percentages for the Extended With Prompting measures of clinical data accuracy and completeness. These results were compared to the results from Study 1. Z-tests for differences between proportions were computed for each pair of percentages. An examination of the results showed significant improvement in all but two categories of documentation accuracy and completeness. No significant improvement was noted in the documentation of amputation injury or sucking chest wound treatments. Significant improvements, however, were observed in the eight remaining categories of data quality. For example, both sucking chest wound and amputation injuries were accurately and completely documented in 81 percent of the cases compared to a rate of 62 percent for the Extended mode. In the case of treatment

documentation, both sucking chest wounds and amputations were accurately and completely documented in 78 percent of the observations. This represented a performance improvement of more than 30 percent compared to that obtained for the Extended mode alone. Perfect documentation performance was realized in the categories of patient condition and patient disposition. Further, when injury documentation results from the MEDTAG Extended With Prompting were compared to the results obtained with the FMC (Table 5) no significant differences were found. Therefore, the revised design retained the advantages for documenting treatment data and removed the previous disadvantage associated with injury documentation.

Table 3
MEDTAG Initial Prompted and Prompted With Extended Documentation Time

		MEDTAG Initial Prompted Sequence		MEDTAG Prompted With Extended	
Location/ Time of Day	n	Mean Time (sec)	SD	Mean Time (min/sec)	SD
OVERALL	88	0:41	0:14	2:13	0:37
BATTLEFIELD	39	0:40	0:09	2:16	0:34
Day	17	0:46	0:11	2:24	0:39
Twilight	08	0:32	0:05	1:49	0:26
Night	14	0:39	0:08	2:23	0:33
BATTALION AID STATION	49	0:41	0:14	2:10	0:32
Day	27	0:35	0:15	1:54	0:30
Twilight	12	0:44	0:09	2:15	0:29
Night	10	0:52	0:18	2:45	0:43

Table 4

Percentage of MEDTAG Extended and Extended With Prompting Data Input Information Accurately and Completely Documented

MEDTAG Extended Input n = 87	MEDTAG W/ Prompted Input n = 88	z Score	Type of Documentation
			Specific Injury Type Documentation
74.71%	92.05%	3.08*	o Sucking Chest Wound
77.01%	85.23%	1.39	o Amputation
			Specific Injury Location Documentation
77.01%	88.64%	2.04*	o Sucking Chest Wound
80.46%	90.91%	1.98*	o Amputation
			Overall Injury Documentation
62.07%	81.82%	2.91*	o Both Sucking Chest Wound & Amputation
			Specific Treatment Documentation
78.16%	88.64%	1.87	o Occlusive Dressing applied for Sucking Chest Wound
60.92%	81.82%	3.06*	o Pressure Band., or Tourniquet w/ Band., used on Amputation
			Overall Treatment Documentation
57.47%	78.41%	2.97*	o Both Sucking Chest Wound & Amputation
			Patient Condition Documentation
52.87%	100.00%	7.34*	o Patient Condition
			Patient Disposition Documentation
70.11%	100.00%	5.53*	o Patient Disposition

* $p < .05$

Table 5

Percentage of Field Medical Card and Extended With Prompting Data Input Information Accurately and Completely Documented

Field Medical Card n=89	MEDTAG W/ Prompted Input n=88	z Score	Type of Documentation
			Specific Injury Type Documentation
94.38%	92.05%	-0.62	o Sucking Chest Wound
90.70%	85.23%	-1.12	o Amputation
			Specific Injury Location Documentation
95.51%	88.64%	-1.69	o Sucking Chest Wound
91.86%	90.91%	-0.22	o Amputation
			Overall Injury Documentation
80.90%	81.82%	0.16	o Both Sucking Chest Wound & Amputation
			Specific Treatment Documentation
57.30%	88.64%	4.69*	o Occlusive Dressing applied for Sucking ChestWound
30.34%	81.82%	6.90*	o Pressure Band., or Tourniquet w/Band., used on Amputation
			Overall Treatment Documentation
26.97%	78.41%	6.85*	o Both Sucking Chest Wound & Amputation
			Patient Condition Documentation
10.11%	100.00%	12.01*	o Patient Condition
			Patient Disposition Documentation
01.12%	100.00%	13.16*	o Patient Disposition

* $p < .05$

CONCLUSIONS

This field evaluation of the operational effectiveness of the MEDTAG prototype demonstrated the benefits of automated battlefield medical data collection. Using the MEDTAG's menu-driven approach to data collection reduced the time required for documentation and improved the value of the documentation obtained when compared to current manual methods. The improvement in documentation performance was achieved partly because the pre loaded demographic data allowed for the accurate identification and accounting of all personnel. Previous studies have shown that the FMC requires more than 1 min to record patient identification alone and the data provided are often inaccurate or incomplete (Wilcox, Galarneau, & Fitzgerald, 1993). Also, simply activating the MEDTAG initiated a valuable patient injury time line by time-and date-stamping of injury occurrence. These features of the MEDTAG device serve to relieve corpsmen of the responsibility for obtaining all but the most critical data and, therefore, resulted in both reduced time requirements and error rates.

The greatest improvements in documentation time and data quality were achieved by adding a prompting method of data input. Two explanations are proposed for achieving faster overall documentation through the use of prompting. First, search time is reduced because the device presents the user with only those menus that contain information which should be recorded in all, or most, casualty encounters. For example, bleeding control, a required treatment in the majority of combat cases, is presented as one of the menus during the prompting sequence (Fig. 2). In the Prompted mode, users go directly to the type of bleeding control administered and record it, thereby saving the time that would have been used searching the **Treatments Menu** for the same item. Second, the experience the user gains operating the device while it is in the Prompting mode helps achieve faster documentation. Introducing the user to the operation of the device in the Prompting mode provides the treater with a chance to become familiar with MEDTAG's method of operation and functioning before it becomes necessary to enter the data input menu structure. Therefore, users gain sufficient experience with the operation of the device, learn to quickly traverse the menu structure, and locate appropriate items before having to use the self-directed method of the Extended data input mode.

The prompting method may have improved data accuracy and completeness because this initial sequence provided assistance to the user by prompting for many of the treatment and patient condition items that otherwise may have been forgotten. Also, recording critical treatment and patient condition data early resulted in higher documentation accuracy and completeness rates. Furthermore, this method provided the user with the opportunity to spend more time and effort on the recording of injury data, which may explain why this approach produced an increase

in injury data accuracy and completeness scores even though injury diagnosis data were not directly addressed in the Prompted mode.

The results of these studies clearly demonstrated that the MEDTAG device can conduct medical documentation faster than the FMC under stressful conditions simulating combat. Time savings of the magnitude observed in these studies are significant because they give the field corpsman or medic additional resources, which can be applied to providing a higher level of battlefield casualty care.

The time advantage MEDTAG produces is particularly remarkable because the quality of the data was not compromised. The results showed that MEDTAG data quality was comparable to that of the FMC for injury data and surpassed it in all other areas. Therefore, in the areas of treatment, patient condition, and patient disposition, the MEDTAG device collected the required medical information faster, more accurately, and more completely than the FMC collected it.

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APPENDIX A
LISTING OF MEDTAG EXTENDED DATA INPUT MENUS AND DATA ITEMS

MAIN MENU

```
→ASSESS   TREAT   COND
  DISP    REASSES  HELP
YES=ENTER; NO= CHANGE
>ASSESSMENT        12:00
```

INJURY TYPE MENU (ASSESS)

```
PROBLEM TYPE:
→WOUND  HEAT/COLD  NBC
  DISEASE   MORE    EXIT
>WOUND              12:00
```

OTHER TISSUE WOUND MENU (MORE)

```
OTHER TISSUE WOUNDS:
→ STAB   PUNCTURE   BITE
  ABRASION OTHER    EXIT
> STAB              12:00
```

WOUND MENU

```
 WOUND TYPE:
→ TISSUE     MUSCLE/SKEL
  INTERNAL   MORE   EXIT
>TISSUE             12:00
```

PUNCTURE EXIT MENU

```
EXIT WOUND?

PRESS 'YES' OR 'NO'
```

TISSUE WOUND MENU

```
TISSUE WOUND:
→LACERATE  GSW   FRAG
  EVISER    MORE  EXIT
>LACERATION        12:00
```

MUSCLE/SKELETAL MENU

```
MUSCLE/SKEL INJURY:
→ FRACT   DISLOC   AMP
  AVULSION MORE    EXIT
>FRACTURE          12:00
```

GUNSHOT EXIT MENU (GSW)

```
EXIT WOUND?

PRESS 'YES' OR 'NO'
```

FRACTURE MENU (FRACT)

```
OPEN FRACTURE?

PRESS 'YES' OR 'NO'
```

OTHER MUSCLE/SKELETAL MENU

```
OTHER MUSCLE/SKELET:
→SPRAIN   STRAIN   PULL
  OTHER    EXIT
>SPRAIN              12:00
```

COLD PROBLEM MENU

```
COLD PROBLEM:
→ FROSTBITE          OTHER
  HYPOTHERMIA         EXIT
> FROSTBITE          12:00
```

INTERNAL WOUND MENU

```
INTERNAL INJURY:
→ CONCUS  BLUNT  CONTUS
  BLAST   OTHER   EXIT
>CONCUSSION          12:00
```

BURN TYPE MENU

```
BURN TYPE:
→THERMAL          CHEMICAL
 OTHER                EXIT
> THERMAL BURN      12:00
```

OTHER WOUND MENU

```
 OTHER WOUND TYPES:
→ SUPERFICIAL      OTHER
  FOREIGN-OBJ       EXIT
>SUPERFICIAL        12:00
```

THERMAL BURN MENU

```
BURN DEGREE?
→ 1ST        2ND        3RD
  UNKNOWN               EXIT
> 1ST DEGREE          12:00
```

HEAT/COLD PROBLEM MENU

```
HEAT/COLD PROBLEM:
→ HEAT                 COLD
  BURN      MORE       EXIT
>HEAT PROBLEM          12:00
```

CHEMICAL BURN MENU

```
BURN DEGREE?
→ 1ST        2ND        3RD
  UNKNOWN               EXIT
> 1ST DEGREE          12:00
```

HEAT PROBLEM MENU

```
HEAT PROBLEM:
→ STROKE       EXHAUSTION
  DEHYD   OTHER    EXIT
>HEAT STROKE         12:00
```

OTHER BURN MENU

```
BURN DEGREE?
→ 1ST        2ND        3RD
  UNKNOWN               EXIT
> 1ST DEGREE          12:00
```

OTHER HEAT/COLD MENU

```
OTHER HEAT/COLD PROB:
→ SMOK-INHAL        OTHER
  IMMERSION-FOOT    EXIT
>INHALATION         12:00
```

GENERAL LOCATION MENU

```
GENERAL LOCATION:
→ INTERNAL          OVERALL
  MENTAL  NONSPEC   EXIT
> INTERNAL          12:00
```

NBC/CBR AGENT MENU

```
NBC/CBR AGENT:
→ CHEMICAL    RADIOLOGIC
  BIOLOGICAL        EXIT
>CHEMICAL           12:00
```

HEAD LOCATION MENU

```
HEAD LOCATION:
→BASE     TOP       4HEAD
  SIDE    FACE      EXIT
>BASE OF SKULL      12:00
```

DISEASE MENU

```
 DISEASE:
→ RESP    GASTRO    SKIN
  STD     OTHER     EXIT
 >RESPIRATORY       12:00
```

SIDE OF HEAD LOCATION MENU

```
 HEAD SIDE LOCATION:
→ JAW     EAR       TEMPLE
  EXIT
 >JAW               12:00
```

OTHER INJURY MENU

```
 OTHER INJURY TYPE:
→POISON   STROK     STRESS
  INFECT  OTHER     EXIT
 >POISON            12:00
```

WHICH SIDE MENU

```
 WHICH SIDE?
→ LEFT              RIGHT
  BOTH              EXIT
 > LEFT             12:00
```

INJURY LOCATION MENU

```
 PROBLEM LOCATION:
→ GEN HEAD  UPBODY  MID
  PELVIS    EXTREMITIES
 >GENERAL           12:00
```

FACE LOCATION MENU

```
 FACE LOCATION:
→ EYE     NOSE      MOUTH
  CHIN    FACE      EXIT
 > EYE              12:00
```

UPPER BODY LOCATION MENU

```
UPPER BODY LOCATION:
→NECK          SHOULDER
 CHEST             EXIT
>NECK             12:00
```

ARM LOCATION MENU

```
ARM LOCATION:
→UPPER   ELBOW    4ARM
 WRIST HAND FING  EXIT
>UPPER            12:00
```

CHEST WOUND MENU

```
SUCKING CHEST WOUND?

PRESS 'YES' OR 'NO'
```

LEG LOCATION MENU

```
LEG LOCATION:
→UPPER  KNEE  SHINCALF
 ANKLE FOOT TOE EXIT
>UPPER LEG        12:00
```

MIDSECTION LOCATION MENU

```
MIDSECTION LOCATION:
→SPINE          ABDOMEN
 SIDE     BACK     EXIT
>SPINE            12:00
```

TREATMENTS MENU

```
TREATMENTS:
→DRESS   APPS     AIRWAY
 MEDS    MORE      EXIT
>DRESSINGS        12:00
```

PELVIS LOCATION MENU

```
PELVIS LOCATION:
→HIP            BUTTOCKS
 GENITALS          EXIT
>HIP              12:00
```

DRESSINGS MENU

```
DRESSINGS:
→BATTLE  WET  PRESSURE
 OCCLUS  MORE    EXIT
>BATTLE           12:00
```

EXTREMITIES LOCATION MENU

```
EXTREMITIES LOC.:
→ARM       LEG      EXIT

>ARM              12:00
```

OTHER DRESSINGS MENU

```
OTHER DRESSINGS:
→MUSLIN  RGAUZE   GEL
 VGAUZE  OTHER    EXIT
>MUSLIN           12:00
```

APPLICATIONS MENU

```
APPLICATIONS:
→TOURN   SPLINT   SLING
 SWATHE  MORE     EXIT
>TOURNIQUET       12:00
```

MEDICATIONS MENU

```
MEDICATIONS:
→ATROP   2PAM     VALIUM
 IV MORPH OTHER   EXIT
>ATROPINE         12:00
```

OTHER APPLICATIONS MENU

```
OTHER APPLICATIONS:
→DECON-WIPE       TUBE
 IMMOBILIZE       EXIT
> DECONTAMINATE   12:00
```

ATROPINE MENU

```
ATROPINE INJECTORS:
 PAST 24 hr. TOTAL: 0
→1  2  3  4  5  EXIT
>1 INJECTOR      12:00
```

IMMOBILIZE MENU

```
IMMOBILIZATION OF:
→PATIENT
 OBJECT          EXIT
>PATIENT         12:00
```

TWOPAM MENU

```
2PAMCHLOR INJECTORS:
 PAST 24 hr TOTAL: 0
→1  2  3  4  5  EXIT
>1 INJECTOR      12:00
```

AIRWAY MENU

```
AIRWAY TREATMENTS:
→VENT  INTUBATE  TRACH
 CRICO  OTHER    EXIT
>ASSISTED VENT   12:00
```

VALIUM MENU

```
VALIUM (mg):
 PAST 24 TOTAL: 0
→ 5        10    EXIT
> 5 mg           12:00
```

INTUBATE MENU

```
INTUBATION TYPE:
→ET-TUBE         NG-TUBE
 EXIT
>ET TUBE         12:00
```

IV MENU

```
IV's:
→RINGERS         SALINE
 D5W    BLOOD    EXIT
>R. LACTATE      12:00
```

MORPHINE MENU

```
MORPHINE (mg)
PAST 24 hr TOTAL: 0
→8    16    24    32    EXIT
>8 mg          12:00
```

RESPIRATION MENU

```
RESPIRATION PER MIN:
→NONE      1-5       6-9
 10-29     30+       EXIT
>NONE                12:00
```

OTHER TREATMENTS MENU

```
OTHER TREATMENTS:
→AFFECTED SIDE      CPR
 SHOCK  OTHER       EXIT
> PLACED ON SIDE    12:00
```

DISPOSITION MENU

```
DISPOSITION:
→ACTION TAKEN
 PROVIDER           EXIT
>ACTION TAKEN       12:00
```

CONDITION MENU

```
PATIENT CONDITION:
→SHOCK  CONSCIOUSNESS
 PULSE      RESP    EXIT
> PATIENT IN SHOCK  12:00
```

DISPOSITION TAKEN MENU

```
ACTION TAKEN:
→EVACUATED  RETURNED
 EXPIRED            EXIT
>EVACUATED          12:00
```

CONSCIOUSNESS MENU

```
CONSCIOUSNESS LEVEL:
→ALERT   VERBAL   PAIN
 UNRESPONSIVE     EXIT
>ALERT            12:00
```

EVACUATION MENU

```
EVACUATION TYPE:
→MEDEVAC  AMBULATORY
 EXIT
>MEDEVAC          12:00
```

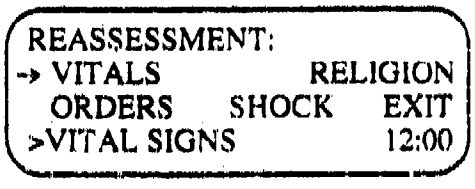
PULSE MENU

```
PULSE:
→NONE      1-59      60-99
 100+                EXIT
>NONE                12:00
```

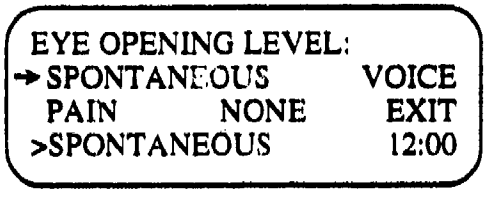
PROVIDER MENU

```
MEDICAL PROVIDER:
→CORPSMAN  BUDDY    SELF
 DOCTOR    OTHER    EXIT
>CORPSMAN/MEDIC     12:00
```

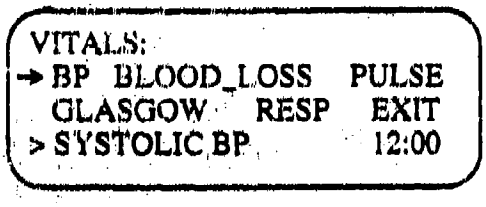
REASSESSMENT MENU



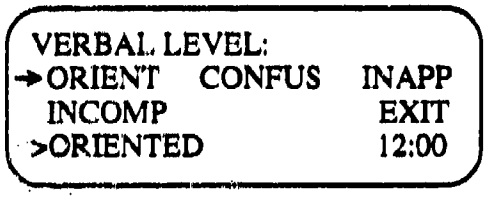
EYE OPENING MENU



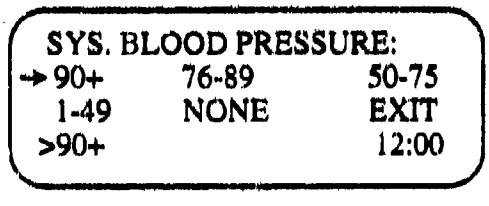
VITALS MENU



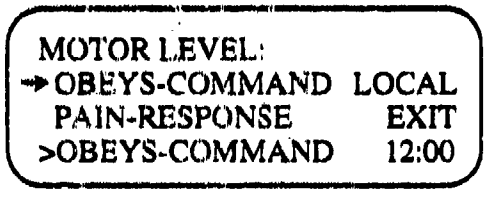
VERBAL MENU



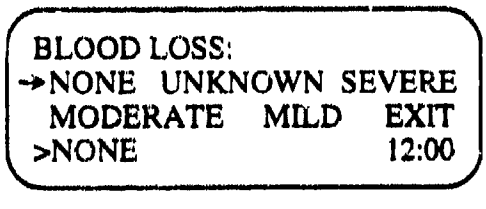
BLOOD PRESSURE MENU



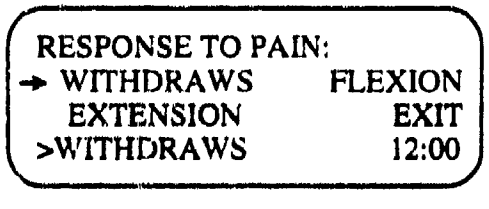
MOTOR MENU



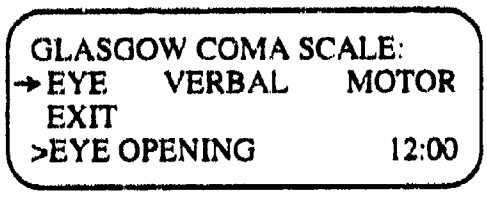
BLOOD LOSS MENU



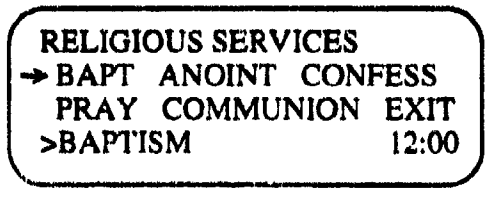
PAIN RESPONSE MENU



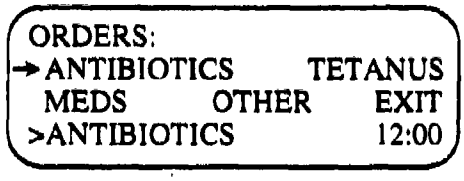
GLASGOW MENU



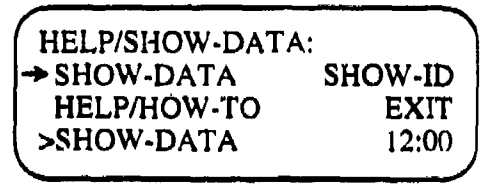
RELIGIOUS SERVICES MENU



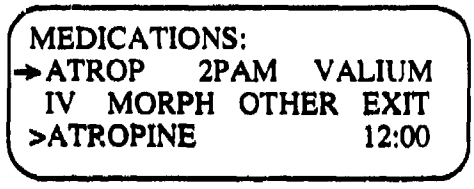
ORDERS MENU



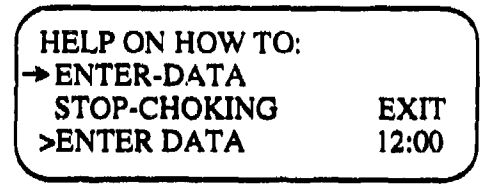
HELP/SHOW DATA MENU



MEDICATIONS MENU



HELP MENU



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13. ABSTRACT *(Maximum 200 words)*

Paper-and-pencil approaches to medical documentation, when used in the battlefield, often fail to provide adequate casualty injury and treatment records. To address this problem, the effectiveness of an automated field medical data collection device, named MEDTAG, was evaluated. Results of the study demonstrated that the MEDTAG device could significantly reduce documentation times when compared to the current manual method (Field Medical Card, DD Form 1380) (FMC). Furthermore, the accuracy and completeness of information gathered with the MEDTAG was comparable to the FMC in the area of injury data and superior to the FMC in the areas of treatment, patient condition, and patient disposition.

14. SUBJECT TERMS
MEDTAG, Field Medical Card, DD Form 1380, Automated Field Medical Data Collection

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